About Coagulation and Flocculation

Reprinted from Water Specialists Technologies LLC

In wastewater treatment, the processes of coagulation and flocculation are employed to separate suspended solids from water. Although the terms coagulation and flocculation are often used interchangeably, or the single term “flocculation” is used to describe both; they are, in fact, two distinct processes.

Knowing their differences can lead to a better understanding of the clarification and dewatering operations of wastewater treatment.

Finely dispersed solids (colloids) suspended in wastewaters are stabilized by negative electric charges on their surfaces, causing them to repel each other. Since this prevents these charged particles from colliding to form larger masses, called flocs, they do not settle.

To assist in the removal of colloidal particles from suspension chemical coagulation and flocculation are required. These processes, usually done in sequence, are a combination of physical and chemical procedures.

Chemicals are mixed with wastewater to promote the aggregation of the suspended solids into particles large enough to settle or be removed.

Coagulation is the destabilization of colloids by neutralizing the forces that keep them apart. Cationic coagulants provide positive electric charges to reduce the negative charge (zeta potential) of the colloids. As a result, the particles collide to form larger particles (flocs). Raid mixing is required to disperse the coagulant throughout the liquid. Care must be taken not to overdose the coagulants as this can cause a complete charge reversal and restabilize the colloid complex.

Flocculation is the action of polymers to form bridges between the flocs, and bind the particles into large agglomerates or clumps. Bridging occurs when segments of the polymer chain adsorb on different particles and help particles aggregate. An anionic flocculant will react against a positively charged suspension, adsorbing on the particles and causing destabilization either by bridging or charge neutralization.

In this process it is essential that the flocculating agent be added by slow and gentle mixing to allow for contact between the small flocs and to agglomerate them into larger particles. The newly formed agglomerated particles are quite fragile and can be broken apart by shear forces during mixing. Care must also be taken to not overdose the polymer as doing so will cause settling/clarification problems. Anionic polymers themselves are lighter than water. As a result, increasing the dosage will increase the tendency of the floc to float and not settle.

Once suspended particles are flocculated into larger particles, they can usually be removed from the liquid by sedimentation provided that a sufficient density differential exists between the suspended matter and the liquid. Such particles can also be removed or separated by media filtration, straining or floatation. When a filtering process is used, the addition of a flocculant may not be required since the particles formed by the coagulation reaction may be of sufficient size to allow removal. The flocculation reaction not only increases the size of the floc particles to settle them faster, but also affects the physical nature of the flow, making these particles less gelatinous and thereby easier to dewater.